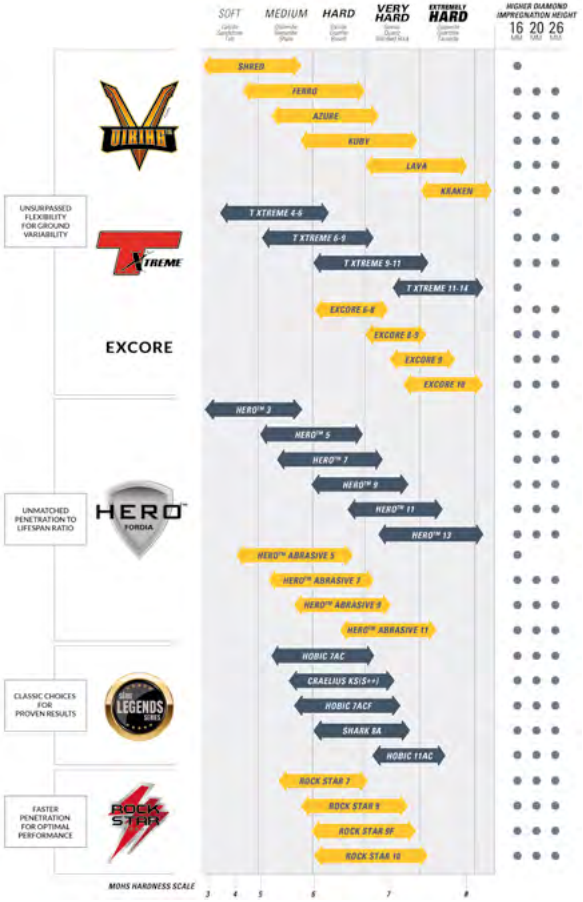
FORDIA®

Powered by Epiroc

Diamond Driller's Technical Book

Practical Guide

Matrix chart selection



General identification

Name _____

Address _____

Postal Code _____

Phone _____

_____

_____

Business Name _____

Address _____

Postal Code _____

Phone _____

Email _____

Table of contents

Safety

An accident is an unplanned event caused by an unsafe act or condition.

Most accidents can be prevented through:

- Proper training.
- Proper supervision.
- Correct use of tools and equipment.
- Safe working practices.

Some safety rules:

- Wear well fitting protective clothing.
- Wear your hard hat, eye protection and safety boots.
- Use your safety belt and life line.
- Don't wear rings and jewelry at work.
- Use the right tool for the job and use it correctly.
- Don't try to repair moving machinery.
- Store your tools properly.
- Don't rush.
- Keep your work place neat and safe.
- Lift heavy objects properly.
- Know and respect fire hazards.
- Check wire rope and other equipment regularly.
- Replace worn equipment.
- Know your equipment. Study the operation manuals and follow the suppliers safety recommendations.

The professional Diamond Driller

Introduction

Successful exploration drilling results from a clear understanding and cooperation between two professionals, the Diamond Driller and the Geologist. Drilling operations are controlled by geologists but they lack the knowledge and experience to optimize the operation of the drill. The Professional Diamond Driller should not hesitate to share his knowledge to improve the operation.

Rock formations

The geological classifications of rock types are based on chemistry and structure. The hardness classification is a relative scale. So called soft rocks can prove more difficult to drill than hard rock and the same formations, in separate locations, can drill very differently.

A specific rock type can change drastically, even in the same drill hole, requiring another choice of drill bit. Each rock type must be considered as a range with a number of variables affecting its drillability.

The factors most affecting the drillability of rock are: grain size, rock hardness, weathering and fracturing. Larger grain size and fracturing make the rock more abrasive, while fine grained, hard rock is less abrasive. Weathering reduces rock strength.

Initial drill settings

Revolutions Per Minute (RPM)

The RPM is given as a fairly broad range. A number in the middle of the range should be used when starting and adjusted as required.

Rate of Penetration (ROP)

Again, this is given as a range and will have to be adjusted as the WOB and RPM are varied.

Gallons Per Minute/Litres Per Minute (GPM/LPM)

The water flow is given as a minimum and the actual pump setting should be well above this.

Weight On Bit (WOB)

The weight on bit given is the maximum advisable. The initial drill setting should be below this.

Performance

Bit performance

Sharp diamonds cut rock, as they become dull they do so less effectively. The bit matrix should wear at a rate that continually exposes sharp diamonds and releases the worn ones.

Flushing fluid should be pumped across the bit at a rate that removes each tiny rock chip as it is loosened by the diamonds. Failure to do this results in the chip being re-ground, and the ROP and bit life are adversely affected.

The WOB is required to make the diamonds bite into the rock.

The RPM determines the rate at which the chips are being gouged from the rock.

Through his knowledge and experience the Professional Diamond Driller balances all these parameters to achieve the best, economic performance from the drill and drilling tools.

While the manufacturer does his best to make drill setting recommendations, he cannot know what rock type or conditions the bit will eventually be used in.

Other factors affecting drill settings are:

- The size and power of the diamond drill.
- The type and size of the core barrel used.
- The flushing media.

Fordia Powered by Epiroc has world wide experience and specially trained representatives to assist you.

ROP

The rate of penetration is the key parameter when drilling with impregnated bits. Finding the optimum ROP for a given rock type, rock condition, bit and model of diamond drill is the goal of the Professional Diamond Driller. Once found, this ideal ROP is maintained by adjusting the WOB and RPM. A high water flow across the bit face should always be maintained at high rates of penetration.

Optimum ROP ensures:

- The best overall economy of the operation.
- The least work and highest rewards for the drill crew.
- That the bit remains sharp and does not polish.
- The best bit life.

Use the recommended ROP on the bit label as a starting point and then vary the WOB and RPM in small increments until the optimum ROP is found.

Alert! An excessive ROP will result in a high rate of matrix wear and diamonds will be expelled while they are still sharp. In this case any gain in ROP may be offset by more frequent bit changes, more work for the drill crew and an overall reduction in the economy of the operation.

WOB

The weight placed on the bit depends on the rock type and condition, bit type, RPM, ROP and water flow.

The WOB is a very important indicator of the actual drilling conditions.

Excessive WOB can result in:

- Abnormal bit wear.
- Hole deviation.
- Core barrel and rod damage.

Too little WOB will also result in a loss of productivity as the bit will lose its ability to self-sharpen and could become polished (see section 4- Bit sharpening).

Try to maintain a constant penetration rate by increasing the WOB if the ROP falls.

Max WOB shown in the table below should never be exceeded to avoid bit or core barrel damage.

Max WOB kN (lb)					
Bit size	A	B	N	H	P
Max WOB	22 (5000)	30 (6400)	40 (9000)	50 (11000)	60 (13500)

Alert! The maximum permitted WOB shown in the Max WOB table is based on the structural integrity of the bit and may result in damage to the rod and core barrel if exceeded. Excessive WOB can also lead to hole deviation.

RPM

Rotation of the drill bit causes the diamonds to tear chips from the rock. Therefore, generally speaking, the more rotations per minute the higher the ROP. The rotation speed also serves to work the matrix to achieve a constant rate of exposure of new sharp diamonds and release of the worn ones.

RPM chart					
Bit size	A	B	N	H	P
RPM min	1500	1200	900	750	600
RPM max	1700	1450	1200	950	750

Alert! Excessive RPM without matching penetration rate can result in polishing the bit and negatively affect the overall drilling economy.

Flushing

Drilling performance is directly related to the fluid flow over the bit. Fluid flushing fills the following functions.

- Removal of cuttings.
- Cooling the bit.
- Lubricating the bit and rod.

Annular fluid velocity must be sufficient to keep the cuttings suspended. Recommended fluid flow for each hole size can be found in the table below.

Flow chart l/min (US gal/min)					
Bit size	A	B	N	H	P
Flow min	15 (4)	30 (8)	38 (10)	50 (13)	75 (20)
Flow max	20 (5)	36 (10)	45 (12)	60 (16)	84 (22)

RPI / RPC

Revolutions per inch (or centimeter) of advance has been used in the past as an index to maintain the correct relationship between RPM and ROP, eg for a rotation speed of 1200 RPM and a penetration rate of 6 in (15 cm) per minute:

RPI = 1200/6 = 200

RPC = 1200/15 = 80

The common recommendation of 200 - 250 RPI (80 - 100 RPC) can only be considered as a starting point: in modern drilling practices much higher penetration rates are often expected for a given rotation speed, resulting in a lower RPI value. Epiroc bits have been developed to accommodate these conditions.

Vibration

Excessive drill rod vibrations result in:

- High rig maintenance cost and early component failure
- Stress fatigue and premature failure of drill rod and core barrel.
- Impacts on the bit and premature failure
- Loss of core
- Lower efficiency and high energy/fuel consumption

Excessive vibration can be the result of:

- Misaligned in-the-hole equipment.
- Undersize, worn, bent or oval rod.
- Vibration induced from the chuck or drill head.
- Incorrect pressure and volume of fluid.
- Loose rod not properly torqued.
- Drilling over core.
- Incorrect bit selection.
- Failed bit.
- Improper use of rod grease.
- Worn or improper reaming shell causing insufficient core barrel stabilization.

Some vibration is inevitable in rotating equipment. It can become excessive and destructive when a number of factors such as RPM, WOB, rock type, bit type, etc., are combined in proportions that set up large vibrations, After eliminating any cause related to the above list, the professional diamond driller can usually find a combination of WOB and RPM that eliminates the excess vibration and gives a good ROP.

Drilling tips

Always

- Treat diamond bits with care and store properly.
- Start fluid circulation before running the bit to bottom.
- Start a new bit several centimeters above bottom and spin into the formation. Do not go to full ROP until you have drilled 10-20 centimeters (4-8 inches).
- Check all rod joints for leaks.
- Check the rod and core barrel for alignment.
- Keep the inside of rod and core barrel free from scale and dirt.
- Make sure the reaming shell is within gauge and out lasts the bit.

Never

- Drop the bit onto the hole bottom.
- Start the bit turning with weight on it.
- Collar a hole with a new bit.
- Contact the bit matrix with a pipe wrench.
- Grind the core.
- Allow vibration to occur.
- Force the bit, if it will not drill with normal pressure.

Sharpening a bit

Impregnated bits are self sharpening. As the matrix wears away new sharp diamonds are exposed at a constant rate. However, sometimes the diamonds on the face of the bit can become worn without the matrix abrading away. The bit will stop cutting. Generally this occurs when:

- The drill settings do not suit the conditions.
- The bit does not suit the rock.

This often results from rapid formation change.

The bit can be sharpened in the hole and drilling continued but this is a tricky operation and may consume a lot of matrix.

To sharpen the bit, momentarily increase the WOB by 15 to 20 percent, while at the same time reducing the water flow to near the minimum indicated on the bit label.

When the bit begins to cut, immediately lower the WOB and increase the water flow. Try different drill settings than used previously to prevent reoccurrence of the problem.

The right choice

Optimum bit wear

	Analysis
	Bit feels sharp to the touch Good comet tails (diamonds on bit face well supported at the back side by metal alloy) The wear is even OD and ID within gauge

Why? Possible reasons

Rock related: This bit was well suited to the rock formation and conditions.

Drilling related: Drill setting sand flushing provided optimum drilling.

Bit related: The diamond and matrix wear are balanced to provide optimum performance.

What to do? Possible solutions

Drilling related: Continue to use the same drill settings unless the conditions change.

Bit related: Continue to drill with this bit type unless the rock formation and conditions change.

Alert! Continue to watch for changes in the rock conditions and the performance of the drill.

What went wrong?

Matrix erosion and overly exposed diamond

	Analysis
	Very rough to the touch Rapid crown wear Diamonds overexposed Gauges eroded

Why? Possible reasons

Rock related: Formation may have changed and is too coarse grained, fractured or abrasive for the bit used.

Drilling related: Drilling pressure is too high for the speed of rotation. The solids content in drilling fluid may be too high. Excessive drilling pressure causing a high rate of matrix wear and premature diamond release.

Bit related: Matrix too fast wearing (soft), or waterway design unsuitable.

What to do? Possible solutions

Drilling related: Increase speed of rotation and reduce the drilling pressure. Increase drilling fluid flow.

Bit related: Change bit to harder matrix or different waterway design. Reduce the drilling pressure if optimum bit life is to be achieved.

Alert! Advance carefully when re-entering the hole if there has been a lot of gauge wear.

What went wrong?

Concave face wear

	Failure analysis
	Bit wear uneven Face wear angled to ID Diamonds poorly supported ID gauge loss

Why? Possible reasons

Rock related: Formation may have changed to a coarser grained, abrasive or fractured rock type.

Drilling related: The solids content of the drilling fluid may be too high. May be core grinding. Rotary is speed too low or too high drilling pressure.

Bit related: Matrix too soft or unsuitable waterway design.

What to do? Possible solutions

Drilling related: Increase the rotary speed or reduce the drilling pressure. Lower solids in the drill fluid. Check the pump and drills string for leaks, increase pump output. Check and adjust length of the inner tube.

Bit related: Try harder matrix bit or one with a different waterway configuration.

Alert! Continued drilling with concave face wear will cause the bit ID to ring-out.

What went wrong?

Convex face wear

	Failure analysis
	Outer edge of the face rounded OD gauge wear

Why? Possible reasons

Rock related: Fractured formation.

Drilling related: Poor core barrel stabilization or rod vibration, insufficient fluid flow. Reaming down undersize hole.

Bit related: probably not bit related. Reaming shell may be worn and undersize.

What to do? Possible solutions

Drilling related: Check for vibration, stabilize rod and core barrel, try a different RPM. Check the stability of the drill. Check the pump and drill string for leaks, increase pump output.

Bit related: Change the reaming shell.

Alert! Continued drilling with concave face wear will cause the bit OD to ring-out.

What went wrong?

Polished crown

	Failure analysis
	Smooth to the touch Matrix smeared, glazed appearance No comet tails Waterways restricted

Why? Possible reasons

Rock related: Formation has changed to harder, fine grained and less abrasive conditions.

Drilling related: Drilling pressure too low for the speed of rotation. Water flow is too high.

Bit related: Matrix may be too hard or waterway design unsuitable.

What to do? Possible solutions

Drilling related: Increase the drilling pressure and lower the speed of rotation.

Bit related: Strip or dress the bit before starting to drill. Try a bit with a softer matrix or different waterway design if the problem persists.

Alert! Watch the pump pressure and ROP carefully when starting to drill.

What went wrong?

Burnt bit

	Failure analysis
	Blackened areas Smeared or broken out matrix Closed waterways

Why? Possible reasons

Rock related: Formation may have changed to very fractured rock.

Drilling related: Fluid flow is insufficient. Poor core barrel stabilization or rod vibration. Reaming down undersize hole.

Bit related: Problem not likely bit related.

What to do? Possible solutions

Drilling related: Check the pump and drill string for leaks, increase pump output. Check for vibration, stabilize rod and core barrel. Check the stability of the drill.

Bit related: No change required if the bit is suited to the formation.

Alert! Be very careful when restarting to drill. Watch for pump pressure cut-off, loss of ROP, loss of circulation.

What went wrong?

Cracks in waterways	Failure analysis
	Cracks are initiated And are visible between the bit segments

Why? Possible reasons

Rock related: Formation may have changed to very fractured rock.

Drilling related: The drilling pressure is too much. The rod or inner tube is dropped in a dry hole.

Bit related: Bit might have crushed by a foot clamp or rod holde.

What to do? Possible solutions

Drilling related: Reduce the drilling pressure. In dry hole condition, send the tube back with the wireline.

Bit related: No bit type change is required if the bit suited to the formation

Alert! Continuing drilling with cracked bit might result in segments detachment.

Diamond tools

Core bit selection

Define rock hardness

The simplest and most reliable way to determine rock hardness is to perform a scratch test using an etcher kit and compare the results with Mohs scale.

If you do not have such tools, you can still determine the hardness using a pocket knife or a metal saw, although results may not be as consistent.

If you are using a pocket knife, the average hardness of this tool is approximately 6.0 to 6.5 and if you are using a metal saw, it should be around 6.5 to 7.0 on Mohs scale. For more details on how to perform a scratch test, or to order a Fordia etcher kit, contact your sales representative.

Example

Mike measured an average hardness of 5.5 after performing three scratch tests on samples of his latest project. As the ground is coarse grained and slightly abrasive, his representative suggests he should choose a T XTREME 6-9 bit.

After a couple hundred meters, Mike realizes that the penetration rate is too slow. His representative then suggests he should use a higher number matrix and sends him a couple of HERO 9 core bits.

A week later, the new bits have proven themselves. The penetration rate has improved and Mike has reached the productivity level he was hoping for.

Choose an appropriate bit range

According to the results obtained through the scratch test, select the appropriate bit range with Fordia's Matrix Selection Chart (see inside cover). You should be able to identify at least one matrix that fits your specific needs.

Note that more than one matrix may fit the bit range you are looking for. If the ground is made of a wide range of minerals and several hardness levels have been measured, choose the T Xtreme series. If the ground is relatively homogeneous, choose the HERO and Shark Advanced series.

Evaluate results & make adjustments

As every type of ground is unique, these rules of thumb may not always be enough to find the perfect bit on your first attempt. Abrasiveness, fractures or competence in rock formations are some other major considerations when it comes to choosing a bit.

Reviewing bit performance is important - it may provide critical information to help you find the right bit and to improve productivity.

For example, if the penetration rate is too slow, using a higher matrix could help solve the problem. However, if bit life is too short, try a lower number matrix. For personalized advice, please contact your sales representative.

Note : if you are drilling in deep hole applications, try a Vulcan configuration. The higher diamond impregnation provides greater lifespan and reduces pull-outs.

Core bit configurations

Fordia offers a wide range of waterway configurations to provide you with the best drilling performance, no matter what type of work needs to be done. All of our configurations are available with different waterway widths and come in all matrix heights.

Vulcan configuration

The Vulcan series is a core bit configuration that features a higher crown and higher diamond impregnation, allowing you to improve bit life and replace the core bit less often. The higher the crown, the more meters you can achieve before having to change a bit. This is important in deep hole drilling as the Vulcan configuration can reduce the number of rod pulls required. Available in 16 mm, 20 mm, 26mm.

Increased surface
(more torque required)

Reduced surface area
(less torque required)

Standard

This configuration has been available for a long time. It has been popular since diamond impregnated core bits were introduced and can be used on most impregnated core bits.

Cyclone

The cyclone can increase drilling fluid ejection and is a good choice of configuration for broken ground, clay and shale ground conditions.

Turbo Pie-Shaped

Turbo Pie-Shaped configuration provides good ejection of fluids and rock cuttings. This configuration is suitable for competent ground condition.

Jet-Enhanced

The Jet configuration provides good ejection of fluids and rock cuttings. This configuration offers strong segments suitable for broken ground condition. Jet-Enhanced is optimized for reduced water consumption.

Pie Shaped

The Pie-Shaped configuration is the most popular option. Designed with wedged waterways, it is often the preferred choice when drilling in abrasive conditions.

HERO™ Core Bits

HERO core bits are manufactured individually to provide an unmatched penetration to lifespan ratio. The HERO line allows drillers to achieve excellent drilling performance in ground with rock hardness ranging from 3.5 to 8 on Mohs scale, and is also suitable for softer, abrasive ground.

HERO™ Abrasive Core Bits

Developed specifically for abrasive ground conditions, HERO Abrasive core bits feature a matrix made of special alloys and diamonds. All matrices in this line come in standard 13-mm diamond impregnated height.

ROCKSTAR™ Core Bits

The ROCKSTAR line of products takes versatility and performance to a new level. By adjusting drilling parameters, drillers can increase the penetration rate without sacrificing bit life.

VIKING™ Core Bits

Developed with drillers and for drillers, the VikingTM series includes flexible matrices designed to conquer all types of ground, in all regions of the world.

LEGENDS Core Bits

The Legends core bit series is a new line that honours classical matrices developped by Fordia powered by Epiroc, used for tens of years. These bits are still very popular among experienced drillers and are behind some of the most significant drilling stories. They have withstood the test of time and they continue to deliver great results.

T XTREME Core Bits

Manufactured using polycrystalline diamonds coated with in titanium to protect the tool's cutting abilities during the furnacing process.

GATOR Casing Shoes

GATOR casing shoes are designed to reach the rock quickly so you can start coring quickly. The matrices are impregnated with diamonds and have tungsten carbide inserts to reinforce their internal and external diameters.

RS++

The premium RS++ are reinforced with high-quality natural and synthetic diamonds to maintain precise gage control. A unique wear indicator clearly shows when to change the reaming shell. Available in 6'', 10''and 18''.

White Rhino

White Rhino reamers are made with synthetic and natural diamonds, embedded in a highly resistant matrix, and tungsten carbide inserts.

Nominal hole & core sizes

Hole volume 168 L/100 m

OD: max 46,12 mm/1.816"
min 45,87 mm/1.806"

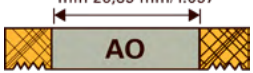
ID: max 35,41 mm/1.394"
min 35,15 mm/1.384"

Reaming Shell
OD: max 46,42 mm/1.828"
min 46,17 mm/1.818"

Hole volume 181 L/100 m

OD: max 47,75 mm/1.880"
min 47,50 mm/1.870"

ID: max 27,10 mm/1.067"
min 26,85 mm/1.057"



Reaming Shell
OD: max 48,13 mm/1.895"
min 47,88 mm/1.885"

Hole volume 181 L/100 m

OD: max 47,75 mm/1.880"
min 47,5 mm/1.870"

ID: max 30,43 mm/1.198"
min 30,18 mm/1.188"

Reaming Shell
OD: max 48,13 mm/1.895"
min 47,88 mm/1.885"

Nominal hole & core sizes

Hole volume 181 L/100 m

OD: max 47,75 mm/1.880"
min 47,50 mm/1.870"

ID: max 35,41 mm/1.394"
min 35,15 mm/1.384"

Reaming Shell
OD: max 48,13 mm/1.895"
min 47,88 mm/1.885"

Hole volume 282 L/100 m

OD: max 59,69 mm/2.350"
min 59,44 mm/2.340"

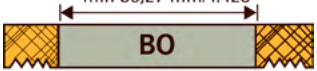
ID: max 42,14 mm/1.659"
min 41,88 mm/1.649"

Reaming Shell
OD: max 60,07 mm/2.365"
min 59,82 mm/2.355"

Hole volume 282 L/100 m

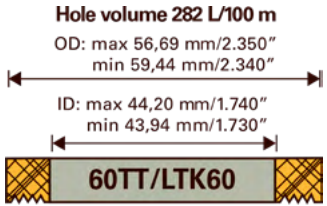
OD: max 59,69 mm/2.350"
min 59,44 mm/2.340"

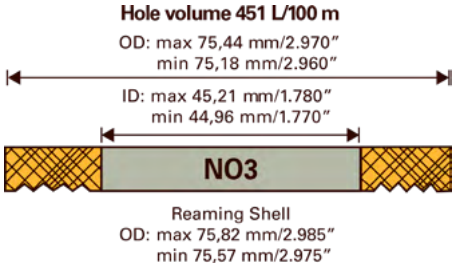
ID: max 36,53 mm/1.438"
min 36,27 mm/1.428"

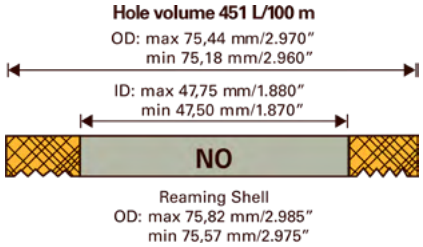


Reaming Shell
OD: max 60,07 mm/2.365"
min 59,82 mm/2.355"

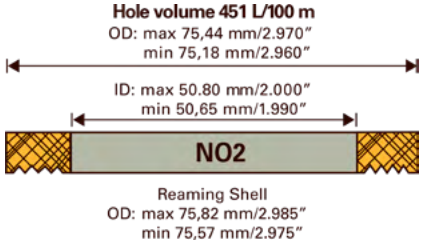
Nominal hole & core sizes

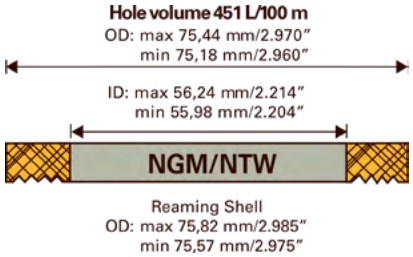


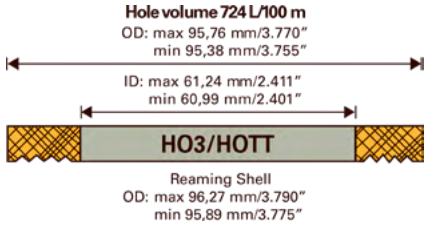




Nominal hole & core sizes

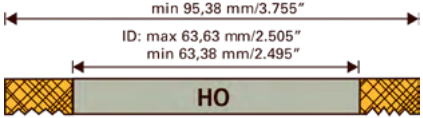






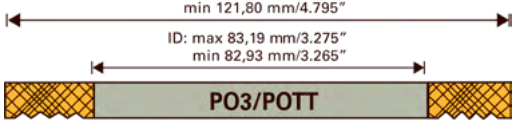
Nominal hole & core sizes

Hole volume 724 L/100 m
OD: max 95,76 mm/3.770″
min 95,38 mm/3.755″



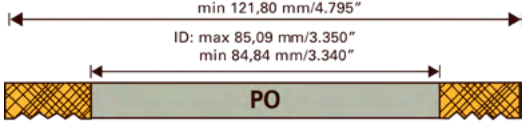
Reaming Shell
OD: max 96,27 mm/3.790″
min 95,89 mm/3.775″

Hole volume 1180 L/100 m
OD: max 122,30 mm/4.815″
min 121,80 mm/4.795″



Reaming Shell
OD: max 122,81 mm/4.835″
min 122,43 mm/4.820″

Hole volume 1180 L/100 m
OD: max 122,30 mm/4.815″
min 121,80 mm/4.795″



Reaming Shell
OD: max 122,81 mm/4.835″
min 122,43 mm/4.820″

Exploration tooling

DiscovOre & Arrow 3S Surface Head Assembly

The DiscovOre Surface head assembly and the Arrow 3S auto-lock overshot combine to create a revolutionary new core barrel system that provides safety, speed and simplicity. The new design has eliminated the weak and potentially hazardous components of a standard core barrel, the spearhead and spring pins.

DiscovOre & Arrow 3S Underground Head Assembly

The DiscovOre underground head assembly provides the same safety features and reliability as the DisvovOre surface version, but with a shorter overall assembly for easier handling in underground operations.

Excore

EXCORE head assemblies are meant for productivity. They allow for safe and efficient insertion or removal of inner tube assemblies. They feature a unique piston latching mechanism that indicates when the system is ready to drill, as well as double seals on front of the latches.

Available for both surface and underground, EXCORE allows you to switch quickly from pump in to downhole drilling, using the same head assembly, therefore keeping inventory down.

OWL L-Latch

The OWL L-Latch head assemblies are suitable for all ground conditions. This assembly is a great option for drillers who are familiar with a link style latch system. The surface version and the underground versions are known and chosen for their durability.

OWL Standard Surface Head Assembly

Fordia's OWL Standard surface head assembly is a proven head assembly system that easily integrates into your existing projects and is renown as the industry standard in head assemblies. With its robust design, this system is ideal for all surface drilling projects.

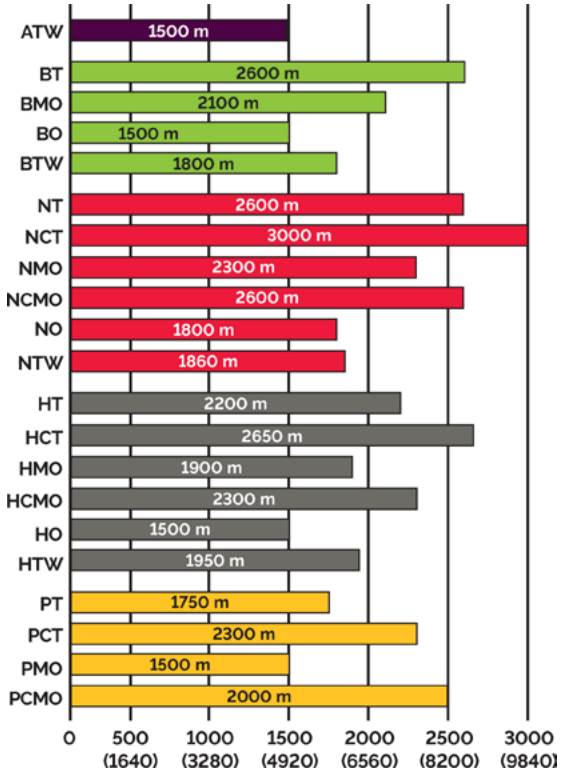
EXCORE EX II Safety Overshot

Excore EX II Safety overshot was developed with both safety and performance in mind. The safety mechanism of this overshot, unlike competing products, is automatic and does not require direct intervention from the drill crew to engage. This overshot simplifies the process and maximizes the speed of each core recovery cycle resulting in increased productivity levels.

Core Lifter Asembly

The core lifter assembly includes three key parts that allow you to firmly grip the core sample so that it can be broken and brought to the surface.

Drill Rods Depth Capacity Chart



Meters (feet)

Recommended maximum depth (m). A factor of safety applies to depth capacities. These are based on straight vertical down holes and fluid filled holes.

Wireline drill rods

Wireline drill rods – Standard

Size	OD mm (inch)	ID mm (inch)	Weight kg/3m (lb / 10 feet)	Content l/100m (gal/328 feet)
AO	44.5 (1.8)	34.9 (1.4)	13.9 (30.6)	96.0 (25.4)
BO/BT/BMO	55.6 (2.2)	46.0 (1.8)	17.9 (39.5)	166.0 (43.9)
NO/NT/NMO	69.9 (2.8)	60.3 (2.4)	22.9 (50.5)	286.0 (75.6)
HO/HT/HMO	88.9 (3.5)	77.8 (3.1)	34.2 (75.4)	477.0 (126.0)
PT/PMO	114.3 (4.5)	101.6 (4.0)	56.0 (123.5)	1180.0 (311.7)

Make up Torque

Once the stand off joint is closed, there is a need to apply additional torque to pre-load the joint sufficiently. The joint will NOT make itself up during normal drilling operation and must be pre-loaded manually with adequate wrench sizes or mechanically with equipment. This is to avoid joints from leaking but also premature fatigue and failure of the joint.

Wireline Drill Rods

Wireline drill rods	Minimum Make up Torque	
	Nm	ft-lbs
AOTW, ATT	340	250
BO, BT, BMO, BTT	400	300
NO, NT, MNO, NTW	600	450
HO,HT,HMO	1000	750
PT, PMO	1000	750

Wireline drill rods – Thin wall

Size	OD mm (inch)	ID mm (inch)	Weight kg/3m (lb / 10 feet)	Content l/100m (gal/328 feet)
ATT/AOTW	44.5 (1.75)	36.8 (1.45)	11.8 (26.01)	106.0 (28.00)
BTT/BOTW	56.5 (2.22)	48.8 (1.92)	15.3 (33.73)	189.0 (49.93)

Conventional Drill Rods & Casing

Conventional drill rods

Size	OD mm (inch)	ID mm (inch)	Weight kg/3m (lb / 10 feet)	Content l/100m (gal/328 feet)
AWJ	44.5 (1.75)	34.9 (1.37)	14.3 (31.53)	75.0 (19.81)
BWJ	55.6 (2.19)	46.0 (1.81)	18.4 (40.57)	155.0 (40.95)
NWJ	66.7 (2.63)	60.3 (2.37)	24.4 (53.79)	256.0 (67.63)

Flush joint casing

Size	OD mm (inch)	ID mm (inch)	Weight kg/3m (lb / 10 feet)	Content l/100m (gal/328 feet)
AW	57.1 (2.25)	48.4 (1.91)	16.9 (37.26)	184.0 (48.61)
BW	73.0 (2.87)	60.3 (2.37)	31.2 (68.78)	285.0 (75.29)
NW/NWT	88.9 (3.50)	76.2 (3.00)	38.8 (85.54)	456.0 (120.46)
HW/HWT	114.3 (4.50)	101.6 (4.00)	50.8 (111.99)	811.0 (214.24)
PW/PWT	139.7 (5.50)	127.0 (5.00)	64.3 (141.76)	1267.0 (334.71)

Drilling additives & lubricants

Fordia offers drilling additives from Matex, the leader in environmentally safe drilling fluids and lubricants. Specialized in drilling fluid systems for diamond, production and development drilling, Matex products help reduce drilling costs. The Matex product line includes a wide variety of drilling additives, such as polymers, foams, lubricants, and more. Please ask our representatives for more information on specific Matex products.

- Reduces re-drills
- Increases production
- Reduces drilling costs

VISCOSITY CONTROL	FLUID CONTROL	TORQUE REDUCER	LUBRICANT
DD-2000	DD X-PAND	TORQUELESS	BIO-CUT PLUS
DD-955	FORM-A-CORE	VIBRA STOP	DD BIT-COOL
ULTRAVIS	MAPAC		
SAND DRILL	SLO-FREEZE ES		

Pumps

The ELEPUMP KF pump series is well known for its performance and easy maintenance, but is mostly selected for its outstanding durability. The KF-30 and KF-40 plunger pump model is best suited for clean water while the KT-45 and KF-50M piston pump model will perform best when there is mud, sediment, bentonite or cement in the water.

Mud Pumps

	Flow rate		Pressure	
KT-45	74 L/min	19,6 GPM	50 bar	750 psi
KF-50M	109 L/min	28,8 GPM	70 bar	1 000 psi

Water Pumps

	Flow rate		Pressure	
KF-30	106 L/min	28 GPM	200 bar	2 9000 psi
KF-40	170 L/min	45,0 GPM	110 bar	1 600 psi

KF-50M
Piston pump

KF-40
Plunger pump

Eddy Water Treatment System

Environmentally friendly practices

EDDY treats drill water in order to separate the cuttings and recycles the drill water.

- Lower environmental impact
- Compliance with current environmental standards
- Re-use of the majority of drill water
- Lower costs of supplying water
- Improved safety for workers

Prism Directional Wedge

Save time and money by wedging quickly and getting back to drilling faster. By using Fordia's Prism Directional Wedge, you can quickly and easily deflect a drill hole to a predetermined direction. The one-trip directional wedge system comes in standard N and H hole sizes.

- Saves time by reducing the number of trips required down the hole
- Reduces drilling downtime by quickly deviating a hole

Aquaguard

Safely cross zones of high groundwater flow during drilling operations and still obtain good core recovery with Aquaguard water pressure limiter.

When inserted into the rods, its check valve limits water from pressurized in-flow zones making drilling operations safer. Aquaguard also reduces operating time by up to 30%. Using Aquaguard makes adding rods and changing the inner tube safer and more efficient while improving core recovery across groundwater flow zones.

OWL Fishing Tool

Due to its unique design, this easy-to-use tool provides the best chance of recovering broken equipment when compared to most other alternatives offered in the industry.

Drilling water pressure triggers the tool's three locking keys on the inside diameter of the equipment, which allows the rods or casing to be recovered almost every time, without damage.

Reverse Circulation Bits

Our bits for Reverse Circulation (RC) drilling are produced according the highest quality control standards.

Our concave bits are available with a patented Trubbnos buttons for longer life and enhanced rate of penetration (ROP) and improved sample quality.

Pipes and Adaptors

Reverse Circulation (RC) pipes are available in both lightweight and robust design. Our DR rods are cold drawn and are friction welded for stronger joints.

Made of quality steel that is heat treated according to our specifications, our DR rods are approximately 23% lighter in weight and can go up to 23% deeper.

Reverse Circulation Hammers

Secoroc RC hammers were developed for all types of exploration drilling, such as grade control and deep hole applications. Our RC hammers give you superior performance, exceptional reliability and dependable support whether you are exploring potential sites or operating an existing mine.

RC50
The Secoroc RC50 features high frequency combined with a high mass piston provide a high output of power, ensuring cutting edge performance and an excellent rate of penetration.

COP RC45 HD
With the same features and benefits as the Secoroc COP45, this heavy-duty version is ideal for conditions that are extra demanding conditions. The HD version apart leverages the best material and the best heat treatment available.

Exploration Drill Rigs

Diamec Smart 6M

A wide range of drill rigs for mineral exploration are available for your drilling projects, including Christensen, Diamec and Explorac machines.

Diamec Smart 6M from Epiroc combines the best of two worlds – the high productivity and accuracy of a Diamec core drilling rig, with the mobility of a robust carrier designed for underground use. The Diamec Smart 6M further enhances this flexible design by adding another dimension – mobility. The carrier is based upon the Boomer S2 platform which is a well-proven Epiroc underground rig.

The Diamec Smart 6M makes the drilling setup process much faster. It also allows for easy positioning – even at the most difficult of angles. The articulated carrier allows it to bend around difficult contours whilst the highly maneuverable boom allows the drill to be positioned in exactly the desired location. This enables the operator to complete the hole and move to the next location quickly and efficiently.

Diamec Smart 8

The Diamec Smart 8 has a versatile design that makes it ideal for most underground core drilling applications. It makes it easy to reach desired drilling position and angle without any adjustments.

The Diamec Smart 8 is equipped with an advanced Rig Control System (RCS) where most of the operations can be performed automatically. The Diamec Smart 8 can also be equipped with a unique rod handling system that offers complete hands free rod handling. Adding and removing of
drill rods, inner tubes and core barrels are completed by the rod handler.

Christensen 140

The Christensen 140 surface core drilling rigs have a well-earned reputation for reliability when it comes safety and performance. Large core samples, a gear driven rotation unit and a constant penetration rate allow the Christensen 140 to boost your productivity and profits. The durable Christensen 140 rig is also designed to help you meet tough environmental protection demands anywhere in the world.

Main benefits

Safety on-site thanks to compliance with the latest EN 16228 safety standards.

High productivity through a new two gear rotation unit which allows increased time between overhaul with minimal maintenance.

High efficiency thanks to a sturdy mast capable of handling 6 meter core barrels

Parts and services

The key to high availability for exploration drillers

The importance of using original parts and regular servicing can never be overstated. Without these elements, no mechanical equipment can be expected to perform well in difficult environments. But there are many other aspects to a complete support package that may sometimes be overlooked.

Genuine replacement parts are engineered to ensure proper, safe and easy maintenance. Kits are sophisticated combinations of genuine parts designed to streamline maintenance operations.

Conversion tables

IMPERIAL MEASUREMENTS

LENGTH

1 inch (in)		25.44 mm
1 foot (ft)	12 in	0.3048m
1 yard (yd)	3 ft	0.9144 m
1 mile	1,760 yd	1.60934 km
1 int. nautical mile	2,025.4 yd	1,852 m

AREA

1 sq inch (in^2)		645.16 mm^2
1 sq yard (yd^2)	9 ft^2	0.8361 m^2
1 acre	4,840 yd^2	4,046.86 m^2
1 sq mile (mile2)	640 acres	2.590 km^2

VOLUME CAPACITY

1 cu foot (p3)	1 728 in3	28.317 dm3
1 cu yard (v3)	27 ft3	0.765 m3
1 US dry pint	0.9689 UK pt	0.55061 l
1 US bushel	1.244 ft3	35.239 l
1 US liquid pint	0.8327 UK pt	0.4732 l
1 gallon	8 US liquid pint	3.7854 l
1 fluid ounce (fl oz)	1.0408 UK (fl oz)	29.574 cm3

MASS

1 grain (gr)		64.7989 mg
1 ounce (oz)	437.5 gr	28.3495 g
1 pound (lb)	16 oz	0.45359 kg
1 short cwt	100 lb	45.359 kg
1 long cwt	112 lb	50.802 kg
1 short ton	20 short cwt	907.185 kg
1 long ton	20 long cwt	1,016.05 kg

METRIC MEASUREMENTS

LENGTH

1 millimetre (mm)		0.0394 in
1 centimetre (cm)	10 mm	0.3937 in
1 metre	100 cm	1.0936 yd
1 kilometre	1,000 m	0.62137 mile

AREA

1 sq cm (cm^2)	100 mm^2	0.1550 in^2
1 sq metre (m^2)	10,000 cm^2	1.1960 yd^2
1 hectare (ha)	10,000 m^2	2.471 acres
1 sq km (km^2)	100 ha	0.3861 mile^2

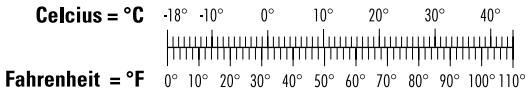
VOLUME CAPACITY

1 cu cm (cm3)		0.0610 in3
1 cu decimetre (dm3)	1 litre	1.816 US dry pint
1 cu metre (m3)	1,000 dm3	1.3080 yd3
1 litre (l)	1 dm3	0.2642 US gal
1 hectolitre	100 l	2.8378 US bus

MASS

1 carat	0.2 g	3.086 gr
1 gram (g)	5 metric carat	0.03527 oz
1 kilogram (kg)	1,000 g	2.20462 lb
1 long ton (t)	2,240 lb	1.1023 short ton
1 short ton (t)	2,000 lb	0.984 long ton

TEMP. CONV. °C/°F



LENGTH

CM	CM/IN	INCHES	KM	KM/MI	MILES
2.54	1	0.394	1.609	1	0.621
5.08	2	0.787	3.216	2	1.243
7.62	3	1.181	4.828	3	1.864
10.16	4	1.575	6.437	4	2.485
12.7	5	1.969	8.047	5	3.107
15.24	6	2.362	9.656	5	3.728
17.78	7	2.756	11.265	7	4.350
20.32	8	3.150	12.875	8	4.971
22.86	9	3.543	13.484	9	5.592
25.40	10	3.937	16.093	10	6.214
50.80	20	7.874	32.187	20	12.427
76.20	30	11.811	48.280	30	18.641
101.60	40	15.748	63.374	40	24.855
127.00	50	19.685	80.467	50	31.069
152.40	60	23.622	96.561	60	37.282
117.80	70	27.559	112.654	70	43.496
203.20	80	31.496	128.748	80	49.710
228.60	90	35.433	144.841	90	55.923
254.00	100	39.370	160.934	100	62.137

AREA

HECTARES	HT/AC	ACRES
0.405	1	2.471
0.809	2	4.942
1.214	3	7.413
1.619	4	9.884
2.023	5	12.355
2.428	6	14.826
2.833	7	17.297
3.237	8	19.769
3.642	9	22.240
4.047	10	24.711
8.094	20	49.421
12.140	30	74.132
16.187	40	98.842
20.234	50	123.553
24.281	60	148.263
28.328	70	172.974
32.375	80	197.684
36.422	90	222.395
40.469	100	247.105

MASS

KG	KG/PDS	POUNDS	TON	T/T US	US TON
0.454	1	2.205	0.907	1	1.102
0.907	2	4.409	1.184	2	2.204
1.361	3	6.614	2.722	3	3.307
1.841	4	8.819	3.629	4	4.409
2.268	5	11.023	4.536	5	5.512
2.722	6	13.228	5.443	5	6.614
3.175	7	15.432	6.350	7	7.716
3.629	8	17.637	7.257	8	8.818
4.082	9	19.842	8.165	9	9.921
4.536	10	22.046	9.072	10	11.023
9.072	20	44.092	18.144	20	22.046
13.608	30	66.139	27.216	30	33.069
18.144	40	88.185	36.287	40	44.092
22.680	50	110.231	45.359	50	55.116
27.216	60	132.277	54.431	60	66.139
31.752	70	154.324	65.503	70	77.162
36.287	80	176.370	72.575	80	88.185
40.823	90	198.416	81.647	90	99.208
45.359	100	220.462	90.719	100	110.231

VOLUME CAPACITY

LITRES	L/IMP.GAL.	IMP.GALLONS
3.785	1	0.220
7.571	2	0.44
11.356	3	0.66
15.142	4	0.88
18.927	5	1.1
22.712	6	1.32
26.498	7	1.54
30.283	8	1.76
34.069	9	1.98
37.854	10	2.2
75.708	20	4.4
113.562	30	6.6
151.416	40	8.8
189.271	50	11
227.155	60	13.2
264.979	70	15.4
302.833	80	17.6
340.687	90	19.8
378.541	100	22

DRILL RODS

SIZE	O.D.		I.D.		WEIGHT		THREADS	VOLUME	
	INCH	MM	INCH	MM	LB/10 FEET	KG/3 M	PER INCH	US GAL./100 FT	L/100 M
AWL	1.7500	44.5	1.3750	34.9	31.0	14.0	4.0	7.70	95.8
BWL	2.1875	55.6	1.8125	46.0	40.0	18.0	3.0	13.40	166.3
NWL	2.7500	69.9	2.3750	60.3	52.0	23.4	3.0	23.00	285.8
HWL	3.5000	88.9	3.0625	77.8	77.0	34.4	3.0	38.20	474.4
PWL	4.6250	117.5	4.0625	103.2	106*	47.2	3.0	67.40	836.6
ATW	1.7500	44.5	1.4370	36.5	26.0	11.8	4.6	8.40	104.5
BTW	2.2250	56.5	1.9090	48.5	34.5	15.8	4.6	14.80	184.5
NTW	2.8750	73.3	2.5250	64.2	50.0	27.7	4.0	26.00	323.0

FLUSH-JOINT CASING

SIZE	O.D.		I.D.		WEIGHT		THREADS	VOLUME	
	INCH	MM	INCH	MM	LB/10 FEET	KG/3 M	PER INCH	US GAL./100 FT	L/100 M
AW	2.750	57.1	1.805	48.4	38	17.2	4	14.80	184.1
BW	2.875	73.0	2.375	60.3	70	31.8	4	23.00	285.8
NW	3.500	88.9	3.000	76.2	86	38.4	4	36.70	455.7
HW	4.500	114.3	4.000	101.6	113	50.5	4	65.20	810.4
PW	5.500	139.7	5.000	127.0	140	64.3	3	102.00	1,266.6

REAMING SHELLS

SIZE	OUTSIDE DIAMETER TOLERANCE			
	MILIMETERS		INCHES	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
AWL	47.88	48.13	1.885	1.895
BWL	59.82	60.07	2.355	2.365
NWL	75.57	75.82	2.975	2.985
HWL	95.89	96.27	3.775	3.790
PWL	122.43	122.81	4.820	4.835
ATW	47.88	48.13	1.885	1.895
BTW	59.82	60.07	2.355	2.365
NTW	75.57	75.82	2.975	2.985
AWLTK	47.88	48.13	1.885	1.895
BWLTK	59.82	60.07	2.355	2.365

DIAMOND CORING BITS

SIZE	CORE DIAMETER			HOLE DIAMETER			HOLE VOLUME	
	DECIMAL	FRACTIONAL	MM	DECIMAL	FRACTIONAL	MM	LITERS/100 M	LITERS/100 M
AWL/AWL-U	1.062	1 1/16	27.0	1.890	1 57/64	48.0	14.60	181.0
BWL/BWL-U	1.432	1 7/16	36.5	2.360	2 23/64	60.0	22.70	282.2
NWL/NWL-U	1.875	1 7/8	47.6	2.980	2 63/64	75.7	36.30	451.0
HWL/HWL-U	2.500	2 1/2	63.5	3.782	3 25/32	96.0	58.30	724.4
PWL/PWL-U	3.345	3 11/32	85.0	4.827	4 53/64	122.6	95.10	1180.4
SWL/SWL-U	4.02	4 3/128	102.0	5.75	5 3/4	146.0	120.00	1266.8
BWL3	1.320	1 5/16	33.5	2.360	2 23/64	60.0	22.70	282.2
NWL3	1.775	1 25/32	45.0	2.980	2 63/64	75.7	36.30	451.0
HWL3	2.406	2 13/32	61.1	3.782	3 25/32	96.0	58.30	724.4
PWL3	3.270	3 9/32	83.0	4.827	4 53/64	122.6	95.10	1180.4
ATW	1.185	1 3/16	30.1	1.890	1 57/64	48.0	14.60	181.0
BTW	1.656	1 21/32	42.0	2.360	2 23/64	60.0	22.70	282.2
NTW	2.205	2 13/64	56.0	2.980	2 63/64	75.7	36.30	451.0
HTW	2.792	2 51/64	70.9	3.762	3 49/64	95.6	57.58	717.8
NWL2	1.990	1 63/64	50.5	2.980	2 63/64	75.7	36.30	451.0
AWLTK	1.200	1 13/64	30.5	1.890	2 57/64	48.0	14.60	181.0
BWLTK	1.602	1 19/32	40.7	2.360	2 23/64	60.0	22.70	282.2

CASING SHOES

SIZE	O.D. / HOLE DIAMETER		I.D.		HOLE VOLUME	
	INCH	MM	INCH	MM	US GALLONS/100 FT	LITERS/100 M
EW	1.875	47.63	1.495	37.97	14.3	178.1
AW	2.345	59.56	1.900	48.26	22.4	278.6
BW	2.965	75.31	2.377	60.38	35.9	445.5
NW	3.615	91.82	3.000	76.20	53.3	662.2
HW	4.625	117.48	3.925	99.70	87.3	1,083.9
PW	5.650	143.51	4.853	123.27	130.2	1,617.5
HWT	4.625	117.48	3.980	101.09	87.3	1,083.9

Acknowledgments

Much of the information contained in this book is the result of the experience gained through many years of close cooperation with our customers. We would like to thank all who have welcomed our technical team in countless areas on the globe. This trust and proximity is invaluable to us.

Another valuable source of information was The Diamond Drilling Handbook by W. F. Heinz. Fordia Powered by Epiroc gratefully acknowledges the important work done by Dr. Heinz.

FORDIA®

Powered by Epiroc

www.fordia.com

T 514 336 9211 TF 1 800 768 7274

 15-02-001